The Development of Publicly-conducted Crop Research in Thailand: An Application of the Theory of Induced Institutional Innovation

AUTHOR(S):

Pochanukul, Patamawadee

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Patamawadee POCHANUKUL*

Crop research in Thailand has developed in several major stages during the past eighty-five years. To improve the technology of agricultural production, the Thai government started its first agricultural experimental station, a sericulture experimental station, in 1902. Public efforts in agricultural research increased considerably after World War II, when intensive research projects for various crops were started. Since 1982, significant changes have taken place in the crop research system in Thailand, with research authorities being decentralized to local research stations, and with rainfed poverty areas being specified by the Department of Agriculture as the main target area for public crop research.

As yet, no systematic economic explanation has been made of this development of crop research in Thailand. The purpose of this study is, thus, to attempt this explanation by applying the theory of induced institutional innovation [Hayami and Ruttan 1985; Ruttan 1978]. By treating institutional change as endogenous to the economic system, the theory provides a framework to explain the historical change of an institution that occurs in association with the economic growth and development of a society.

In the theory of induced institutional innovation, the demand for institutional innovation is induced by changes in product demand, factor endowment, and technical change. That is, by bringing about disequilibria in economic relationships, the three factors create potential benefits to be realized by developing an institution to overcome the disequilibria. The supply of institutional innovation is influenced by the cost of developing the institution, which depends on advances in social science knowledge and cultural endowment. Individuals or groups in a society, as suppliers of institutional change, will innovate or develop an institution when they consider that the expected benefits from the institutional innovation will cover the cost of the innovation [Hayami and Ruttan 1985: 94-114].

In this study, the subject of institutional change is government. Crop research is viewed as an institution that exercises the use of agricultural research resources (scientists, research

* Office of the Research Priorities for Agriculture Project, Planning and Technical Division, Department of Agriculture, Bangkhen, Bangkok, Thailand

facilities, research fund, and so on) in order to produce new knowledge or technology for crop production. Applying Ruttan's definition of 'institutional change',[1] institutional change in crop research in this study refers to: (1) initiation, abolition, or changes in research organization, the rate of growth of research investment and the direction of research (allocation of research resources among regions, crops, and research projects), (2) changes in relationships between research and its environment, such as the needs of farmers and government macro-policies, (3) changes in research policies and process in determining research topics.

The benefits expected by the Thai government from public investment in crop research and from raising the efficiency of the research system are those which would come from advances in the technology of crop production. These include higher and more stable farm income and foreign exchange earnings. To realize these benefits, the Thai government tends to respond to changes in product and factor markets. Thus, changes in agricultural product markets and factor endowments will induce a demand for institutional change in public research. The accumulation of social science knowledge related to research management and rural development will allow consensus to be reached between decision-makers and researchers on how to manage crop research efficiently. This reduces the cost of supplying an institutional change in public research. In this study, institutional and technological advances abroad that are transferred to Thailand as foreign assistance is treated as a factor affecting the supply of institutional change because it will reduce the cost of undertaking a particular design of research. Macro-policies representing interests of government will be taken into account as an institutional environment that influences how government evaluates benefits from and costs of an institutional change. These hypothetical relations are represented by a simple diagram in Fig. 1.

In this study, the period of development for publicly-conducted crop research in Thailand is divided into three periods: period I (1902 - World War II), period II (post-World War II - 1981), and period III (1982 to present). These three periods are recognized because of their different characteristics (in particular, growth and direction) of

1) According to Ruttan [1978], "Institution" refers to an organization ("a decision making unit that exercises the use of resources") and an associated set of behavioral rules ("rules that govern a particular pattern of action of an organization and relationships between an organization and its environment"). "Institutional innovation" or "institutional change" refers to "a change (1) in behavior of a particular organization, (2) in the relationship between such an organization and its environment, or (3) in the rules that govern behavior and relationships in an organization's environments" [Ruttan 1978: 328-329].

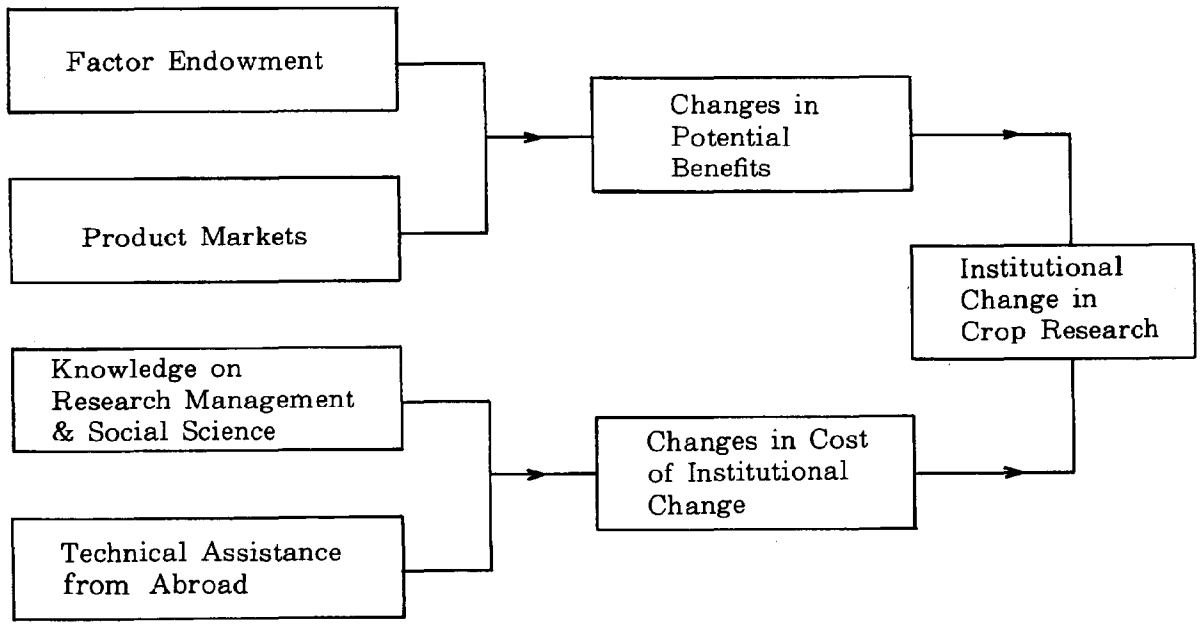

Fig. 1 Induced Institutional Change in Crop Research

research and the different causal relations in institutional changes in each period.

I The Start and Development of Agricultural Research During the Period 1902 – World War II

I-1 *The Start of Agricultural Research in Thailand in 1902*

After the conclusion of the Bowring Treaty of 1855 between Thailand and Great Britain, Thailand opened to the West. State trading by the Thai government was abolished. The import duty was lowered and fixed at 3 percent. This led to an influx of imports such as textiles. On the other hand, an increased demand for rice by the Western colonies in Asia together with the development of cheap ocean transportation created regular and large demand for Thai rice [Ingram 1971].

As shown in Table 1, during the period 1897–1902, the import value of textiles (raw silks, silk cloth, cotton yarns and cotton cloth) doubled and accounted for about 16 to 20 percent of total imports. This increase in import of textiles and the decline in domestic production can be explained by the fact that domestic products were coarser, more expensive, and less appealing than the imports [Ingram 1971 : 113].

The considerable increase in import of textiles induced the start of publicly-conducted agricultural research in Thailand. To improve the quality and lower the costs of production of domestic textiles so that they could be substituted for the imports and, thus, save foreign reserves, the Thai govern-

Table 1 Import Value of Textiles and Total Imports: 1897 - 1902

Year	Value of Textile Imports (Millions of Baht)			Total Value of Commodity Imports (Millions of Baht)
	Total (a)	Raw Silks and Silk Cloth (b)	Cotton Yarns and Cloth (c)	(d)
1897	4.89 (100.0%)	1.40 (28.7%)	3.49 (71.3%)	25.09
1898	5.15 (100.0%)	1.48 (28.7%)	3.67 (71.3%)	29.00
1899	5.40 (100.0%)	1.63 (30.2%)	3.77 (69.8%)	34.60
1900	7.21 (100.0%)	1.73 (24.0%)	5.48 (76.0%)	37.71
1901	7.21 (100.0%)	2.08 (28.9%)	5.13 (71.1%)	43.48
1902	8.92 (100.0%)	1.82 (20.4%)	7.10 (79.6%)	47.65

Sources: Figures for (a), (b), and (c) are from Chao Phraya Wongsanuprapat [1941 : 263]. Figures for (d) are from Ingram [1971 : 332 - 333, Appendix C].

ment established its first experimental station in Bangkok in 1902 to conduct sericultural research. In 1903, the Sericulture Department of the Ministry of Agriculture was established in Bangkok and the first local experimental and extension station in sericulture was set up in Korat, a province in Northeast Thailand and the center of silk production in Thailand at that time. A School for Sericultural Craftsmen was established in Bangkok in 1904. In 1915, a cotton experimental station was established in Phitsanulok, a province in the lower North region.

Table 1 shows that, during 1897-1902, cotton products accounted for about 70-80 percent of the total value of textile imports, while silk products accounted for only 20-30 percent. Also, cotton was widely grown as compared to sericulture [Ingram 1971 : 116]. Considering that knowledge from research has the characteristics of tending to spill over and being non-rivalrous (the knowledge is available to all), the potential benefits from research in terms of foreign reserves saved and aggregate benefits to producers were apparently higher in the case of cotton than sericulture. Why, then, was research started into sericulture before cotton?

In that Thailand had no experience in agricultural research, building up its research capacity (scientists and stock of scientific knowledge and knowledge on agricultural research management) from nothing was a very costly task for the Thai government. The sending of Japanese sericultural experts to Thailand by the Japanese government to give technical assistance in 1902 lowered the cost of establishment of the first research institution and enabled sericultural research to begin in Thailand. This behavior by the Japanese government was motivated by the political purpose of counteracting the Western powers in Asia during the

Table 2 Volume and Value of Rice Exports

Period	Average Volume per Year (Thousand Tons)	Average Value per Year (Thousand Baht)
1870 - 1874	112	5,110
1880 - 1884	215	9,610
1890 - 1894	435	23,780
1900 - 1904	668	61,280
1910 - 1914	913	81,230

Source : Ingram [1971 : Table 3]. Average volume is converted from piculs into metric tons, using the rate 1 picul=60 kilograms.

period of colonization.[2] The Japanese experts took part in research, extension, and education in the field of sericulture in Bangkok and in the Northeast region for ten years (1902－12) [Yoshikawa 1982].

The fact that the Thai government did not start with rice research despite the rapid twelve-fold increase in the export value of rice during the period 1870－1904 (Table 2) can also be explained by the factor endowment condition of the country. At that time, Thailand was relatively land-abundant, as implied by the continuously increasing trend of paddy land-labor ratio from 0.164 hectare per person in 1905 to 0.231 hectare per person in 1915 and 0.260 hectare per person in 1924 [Feeny 1982: 45, Table 4－3]. The Thai government must have thought, and in fact it was the case, that paddy land expansion with the traditional technology was a cheaper and faster way to increase rice production than investment in rice research, a search for new technology which needs skilled personnel and is time consuming. This hypothesis can be supported by the fact that the Thai government imposed policy measures which encouraged the expansion of rice planted area, such as (1) decreasing land tax for a newly cultivated land (1857－1900), (2) eliminating the corvee and slavery system so that a significant amount of labor was freed which sought its own land for rice production (1874－1905), and (3) expanding the system of canals for transportation and for distributing floodwaters over the paddy fields (1881－1910) [Ingram 1971].

2) To counteract the Western powers, the Japanese government sent groups of experts in various fields to Thailand. In 1901, Manjiro Inagaki, a Japanese ambassador, proposed assisting the Thai government in establishing sericultural research in Thailand. Japanese sericultural experts were sent to Thailand in 1902. At that time, sericulture was a fast and successfully developing industry in Japan. During 1868－82, Japanese exports of raw silk and silk products accounted for 45 percent of total Japanese exports. During 1906－10, Japan became the biggest raw silk exporting country [Yoshikawa 1982].

I-2 *The Establishment of the First Rice Experimental Station in 1916*

Table 2 shows that the value and quantity of exports of Thai rice increased greatly throughout the period 1870-1914. The quantity of exports increased eight-fold, while the export value increased sixteen-fold.

Although rice exports soared, the price of Thai rice in the world market around 1910 was low compared with rice from other countries. It was only about one-third of the price of Carolina (U.S.) rice and about a half of the price of Patna (Indian) rice [Chao Phraya Wongsanuprapat 1941 : 318]. This was because the exported Thai rice consisted of a mixture of grain sizes and varieties. At that time, at least 4,000 local rice varieties were found to be grown in Thailand.[3] Since the millers who milled rice for export operated on a relatively large scale, they had to buy paddy of various varieties [*ibid.* : 319] ; and facilities for grading were poor or non-existent.

Expecting a higher revenue for the country from exporting rice of higher quality and price, the Thai government started rice research and extension to improve grain quality of Thai rice. In 1910, rice seed was imported from Carolina and variety trials were conducted on farms in the Central Plain, a major rice-producing area, and in the Northeast [Feeny 1982 : 53]. To identify local varieties with good grain quality and to induce farmers to grow only those good varieties of rice, the Thai government held competitions for rice from all over the kingdom at Bangkok in 1910 and 1911, and established the first rice experimental station in Rangsit (Pathum Thani province) in 1916. Good varieties from the competitions and from selection work at the Rangsit Rice Experimental Station were used in seed multiplication work and then distributed to farmers.

The prewar efforts in rice research raised the standard of grain quality of Thai rice. A meeting of Thai rice millers held in 1926 judged that Thai rice at that time had better grain quality than it had had ten years before [Yupin 1988]. In 1933, 'Pin Gaew', a Thai traditional rice variety from the selection work at the Rangsit Rice Experimental Station, won the first prize for its good grain quality in the World Rice Contest held in Canada.

I-3 *The Slow Development of Crop Research: 1910s - 1920s*

The development of agricultural research in Thailand in the period 1903-09 should be attributed to the efforts made by Prince Phenphattanaphong, a son of King Chulalongkorn. The prince graduated in the field of agriculture from England in 1902. He became the first director of the Sericulture Department during the period 1903-09

3) In 1917, more than 4,000 traditional varieties of rice were collected for selection work at Rangsit Rice Experimental Station [Thailand, DOA 1984 b: 11].

and a Deputy Minister of Agriculture during the same period. Based on his plan, the scope of agricultural experiments and agricultural education was expanded [Johnston 1975: 194]. The Sericulture Department established in 1903 was developed into the Department of Farming in 1906. The School for Sericultural Craftsmen established in 1904 was developed into the Farming School in 1908 and the Agricultural School in 1909. Scholarships were provided for students who graduated from the Agricultural School to continue their study abroad [Chao Phraya Wongsanuprapat 1941]. Prince Phenphattanaphong died in 1909 at the age of only 27 [Johnston 1975: 349].

From 1910 to 1930, some research and extension activities were generated but many of them were later abolished. The slow development of agricultural research during this period can be explained by (1) the decline in interest by the Thai government, partly due to the death of the prince, in developing the agricultural sector as compared with the interest in reforming the country's administrative system and preventing foreign invasion and colonization, (2) the high cost of agricultural research due to the shortage of agricultural scientists and the time lag and uncertain return from research, (3) the declining prices of cotton yarn and raw cotton in the 1920s, and (4) the problem of the government's budgetary deficit during 1920-25. In the following, these factors are explained one after another.

In general, we can state that before 1930 the government's major policies were to reform the country's administrative system and prevent foreign invasion. Relatively little attention was paid to developing the agricultural sector. During 1894-1925, only 3.3 percent of total government expenditure was allocated to activities related to agriculture, as compared with 21.2 percent to defense and 21.1 percent to the interior.[4] This pattern of governmental budgetary allocation implies that, to the government, the expected benefit from spending on development of the agricultural sector (and, thus, agricultural research) was relatively low.

The death in 1909 of Prince Phenphattanaphong, who had a strong interest in developing agricultural research and thus appreciated the expected benefit from research, resulted in the lack of a policy-maker who was interested in the development of agricultural research institutions.[5] Thus, the government abolished many existing research activities and organizations such as the agricultural School, national agricultural exhibitions and rice contests, and all

4) Computed from Pornpen [1984: 468, Table 1 and 480, Figure 1].

5) In that the death of the prince resulted in a lack of policy-makers who were willing to develop agricultural research, I share the idea of Johnston [1975] that the death of the prince delayed the development of agricultural research in Thailand.

sericulture experimental and extension stations.

If the government had an interest in developing agricultural research, it should have invested in agricultural education to increase the supply of agricultural research personnel, who was very scarce at that time. The fact that the government closed the Agricultural School of the Ministry of Agriculture for four years during 1913-16 without explanation implies a lack of governmental interest. From 1917, however, Teacher Training Schools for Agriculture were established in Bangkok and other provinces through the efforts of the Minister of Education.[6] National agricultural exhibitions and rice contests that were held twice in 1910 and 1911 were abolished because, according to the Ministry of Agriculture, the benefit from holding the exhibitions could not cover the cost [Thailand, Ministry of Agriculture 1967]. Sericulture experimental and extension stations in Bangkok and in the Northeast were all closed in 1913. The reason given for the closure by the government was the "failure of the sericultural research to eradicate silkworm diseases (which had spread fast since 1910) and a low benefit from sericultural research and extension as compared with the cost" [*ibid.*: 97]. Some contemporary officers believed, however, that the problem of sericultural research would have been solved if the government had continued supporting this activity for several more years [Yoshikawa 1982: 27].

The high cost, uncertainty, and time lag in the returns from agricultural research, judged by the government, slowed the development of agricultural research during 1910-30. The high cost to the Thai government of agricultural research in the pre-1930 period can be explained by the fact that research requires skilled personnel (scientists), who were very scarce at that time. Thailand had to hire Japanese sericultural experts (1902-12) and an American cotton expert (1915-?), and there was only one Thai agronomist conducting rice research during 1916-32. The hypothesis that, before 1930, the government preferred investments that yielded a certain return can be shown by the fact that the government rejected the request of a foreign company for financial support for its farm-machine research in Thailand.[7] The

6) After the Ministry of Agriculture had rejected his proporsal to reestablish the Agricultural School, the Minister of Education, Chao Phraya Thammasak-Montri, established the first Teacher Training School for Agriculture in 1917 at Bangkok by squeezing out a small portion of the limited budget of the Ministry of Education for the school. From 1923, similar schools for agriculture were established in other provinces. In 1938, these schools were merged to form the Agricultural College at Mae Joe, Chiang Mai province. The college was later moved to Bangkok and developed into Kasetsart University in 1943 [Sam-arng 1985].

7) On private efforts to experiment with farm machinery, see Feeny [1982] and Yupin [1988].

reason given by the government was that it was not certain that the activity would succeed [Yupin 1988: 116–117]. The government also preferred short–term returns from its investments. During 1910－25, the government postponed irrigation projects proposed by the Dutch irrigation engineer Van der Heide because they could not yield short–term returns [Ingram 1971].

The sharp decline in world prices of cotton yarn from 1920 reduced the domestic prices and production of cotton yarn and raw cotton and, thus, lowered the expected benefit from cotton research. The price of imported cotton yarn dropped by almost 50 percent from 4,348 baht per ton in 1920 to only 2,250 baht per ton 1925. This led to an increase of over 240 percent in the quantity of cotton yarn imported during the same period, from 1,380 ton 3,360 ton [Ingram 1971: 120, Table XI]. The decline in domestic prices of cotton yarn and raw cotton resulted in the decline in domestic production of raw cotton as the average planted area of cotton decreased by 26.1 percent from 30.6 thousand rai in 1920－24 to 22.6 thousand rai in 1925－29 [Silcock 1970: 48, Table 3.6]. Also, during 1922－25, the Thai government faced, for the first time, the problem of a continuous budgetary deficit of 2.9 million baht per annum, as compared with the budgetary surplus of 6.9 million baht per annum during 1916－21.[8] For these reasons, in 1925 the government closed the cotton research station that had been established in 1915 [Thailand, Ministry of Agriculture 1967: 98].

Nevertheless, such agricultural research and extension organizations and activities as the Rangsit Rice Experimental Station established in 1916, extension services by local agricultural officers started in 1908, and simple varietal trials of such field crops as maize that were conducted at Teacher Training Schools for Agriculture were continued throughout the pre–1930 period.[9]

I－4 *Revival of Crop Research During the 1930s and World War* II

Thai government tended to pay attention to agricultural research when problems concerning agricultural exports arose such that the possibility of realizing short–run benefits could be increased by investment in agricultural research. One instance was the rice crisis in 1929－30.

During the period of world recession in 1929－30, rice importing countries

8) Computed from Suntaree and Niti [1982: 27, Table 5].

9) During 1920－30, private agricultural research was actively carried out by M. C. Sithiporn. Concentrating on agricultural diversification to lessen the risk of specialization in rice production, he experimented with various crops, cropping systems and mechanization. His efforts and suggestions were largely ignored by the government. Not until 1930 when the rice crisis took place (see section I－4) did the Thai government take note of his suggestions.

preferred to import rice of lower price regardless of quality. Thai rice could not compete with exports from Burma and Vietnam since it had a higher export price [Yupin 1988]. As a result, Thai rice exports dropped from 1.5 million tons in 1928–29 to 1.1 million tons in 1929–30 and to 1.0 million tons in 1930–31, while the average export price per ton rose slightly from 117.4 baht to 121.9 baht, then dropped sharply to 99.6 baht during the same years [Feeny 1982: 127, Table A1-1]. This sharp decline in rice exports in the period of economic depression greatly destabilized Thai economy, which relied heavily on the rice sector.

The crisis stimulated the government to make greater efforts to increase competitiveness of Thai rice in the world market by improving technology to reduce production cost of rice [Yupin 1988]. In addition, to stabilize the economy, the government promoted agricultural diversification. More efforts were made to develop agricultural research and extension, not only for rice but also for other crops. During the 1930 s and World War II, a second rice experimental station was established at Huntra, Ayutthaya province, and agricultural experimental stations for field crops were established in the Northeast (Korat, 1931), South (Songkhla, 1932), and North (Chiang Mai, 1933). A national agricultural research center was established in Bangkok (Bangkhen) in 1941. Varietal tests were made with traditional varieties and new varieties introduced from abroad, such as tobacco, cotton, rubber, maize, kenaf and sugarcane. In 1938, an agricultural college was established under the Ministry of Agriculture at Mae Joe, Chiang Mai province. In 1943, Kasetsart University for agricultural education and research was established in Bangkok.

The revival of agricultural research in the 1930 s and 1940 s were made possible by an increase in the number of agricultural research personnel who had graduated from schools abroad as well as from the teacher training schools for agriculture. Although data on the exact number of agricultural researchers in this period are not available, the names of a number of researchers playing key roles in developing agricultural research in the period are recorded in books on the history of the Department of Agriculture [Thailand, Ministry of Agriculture 1967: 98].

II Crop Research After World War II up to 1981

After World War II, agricultural research in Thailand was strengthened. As shown in Table 3, besides the simple varietal tests and selection works which characterized the crop research of the prewar period, more intensive research programs, such as breeding programs, were started for various crops. Thailand's agricultural research expenditures increased rapidly by 7.4 times during 1959-74. The

Table 3 Initiation of Research Programs for Major Crops in Thailand: Post-World War II - 1960s

Year	Crop	Activity	Foreign Assistance
1950	Rice	Rice Breeding	USDA
1951	Rubber	Rubber Technology*	FAO
1955	Rice	Seed Multiplication	USOM
1959	Maize	Breeding and Cultivation Practices	——
1961	Cotton	Breeding and Cultivation Practices	UK., France
1962	Maize	Breeding and Cultivation Practices	Rockefeller Foundation
1965	Rubber	Varietal Trial and Rubber Technology	UNSF
1966	Rice	Breeding, Cultivation Practices, and Farm Machinery	IRRI and Rockefeller Foundation
1968	Kenaf and Jute	Breeding and Cultivation Practices	——

* 'Rubber Technology' refers to technology for the manufacture of products from natural rubber latex from the tree.
Source: Summarized from [Thailand, DOA 1982].

number of scientific man-years (the amount of time spent by researchers on agricultural research) increased by 4.8 times during the same period [Boyce and Evenson 1975: 30, Table 2. 1]. Experimental stations were established in many parts of the country. The number of rice experimental stations increased from 2 in 1950 to 20 in 1970 and 23 in 1980. The number of experimental stations for rubber, field crops, horticulture, and sericulture increased from about 10 in 1950 to 65 since 1975.

II-1 *The Start of Intensive Research Programs on Major Crops in the 1950s and Early 1960s*

The development of crop research after World War II appears to have been induced by three factors: (1) the postwar increase in export prices of rice and rubber, two major export items of Thailand, which occupied 81 percent of total export value in 1950, (2) the increase in production and export values of maize, cassava, and kenaf, in relation to rice, and (3) assistance from abroad that relaxed the prewar constraints on scientific knowledge and research personnel. The first two factors increased the potential benefit from investment in crop research. The last factor, i.e., assistance from abroad, reduced the cost to the Thai government of conducting crop research.

Right after World War II, largely because of reduced exports from Burma and Indochina, world rice exports decreased to about 40 percent of the prewar level [Ingram 1971: 40-41, footnote 4]. As the result, the world price of rice represented by the average export price of Thai rice doubled from 694.44 baht per ton in 1940-44 to 1,346.80 baht per ton in 1950 (at 1948

constant price).[10]

However, the prewar trend of Thailand's paddy output per capita had been declining, which implied that the traditional method of land expansion alone could not further secure a surplus of rice production for export. During the prewar period of 1930-41, the average annual rate of growth in paddy output for the whole country was 0.55 percent, much slower than 2.22 percent for the population growth rate and 2.26 percent for the expansion rate of paddy area. The average yield per rai of paddy declined remarkably by 1.67 percent per annum.[11] The decline of paddy land productivity occurred as cultivated area was expanded to non-irrigated areas without sufficient improvement of the technology of production [Ingram 1971: 48-49]. As a result, paddy output per capita had declined by 1.63 percent per annum.

To improve the productivity of rice production and take advantage of the favorable export market for rice, the Thai government increased its investment in the rice sector. Fifteen irrigation projects were started from 1948 [Apichai and Montri 1988]. At the request of the Thai government, the USDA (United States Department of Agriculture) sent Dr. H. H. Love as an adviser on rice research to Thailand in 1950 and the Rice Breeding Program was started in that year. In 1953, the Rice Division under the Department of Agriculture was upgraded as the Rice Department, having responsibility for rice research and rice extension.

Regarding rubber, Thailand started exporting rubber in the 1920s. As mentioned in section I-4, some simple varietal tests of rubber were made during the 1930s-1940s. More intensive research into rubber, such as research into rubber technology, was started in 1951 (Table 3). The initiation of intensive rubber research in this year was stimulated by the fast rise in the export price of rubber (at 1948 constant price) from 5,640 baht per ton in 1940-44 to 7,681 baht per ton in 1950 and 11,664 baht per ton in 1951.[12]

Breeding programs for maize, cotton, and kenaf were started in the late 1950s or the early 1960s. The fact that these programs were started after the production and export values of these crops rose in the mid-1950s suggested that the start of these programs were

10) Data on the export price of Thai rice in current terms are from Ingram [1971: 38, Table Ⅲ]. They are deflated by Thailand's index number for cost of living with 1948 as the base year, presented in FAO Production Yearbook of Food and Agricultural Statistics, Volume Ⅸ, part 1, 1955.

11) Calculated from Feeny [1982: 23, Table 3-13 and 47, Table 4-6].

12) The export price of rubber in 1948 prices is calculated similarly to that of rice (See Note 11). Data on the export price of rubber in current terms are from Ingram [1971: 95, Table Ⅸ].

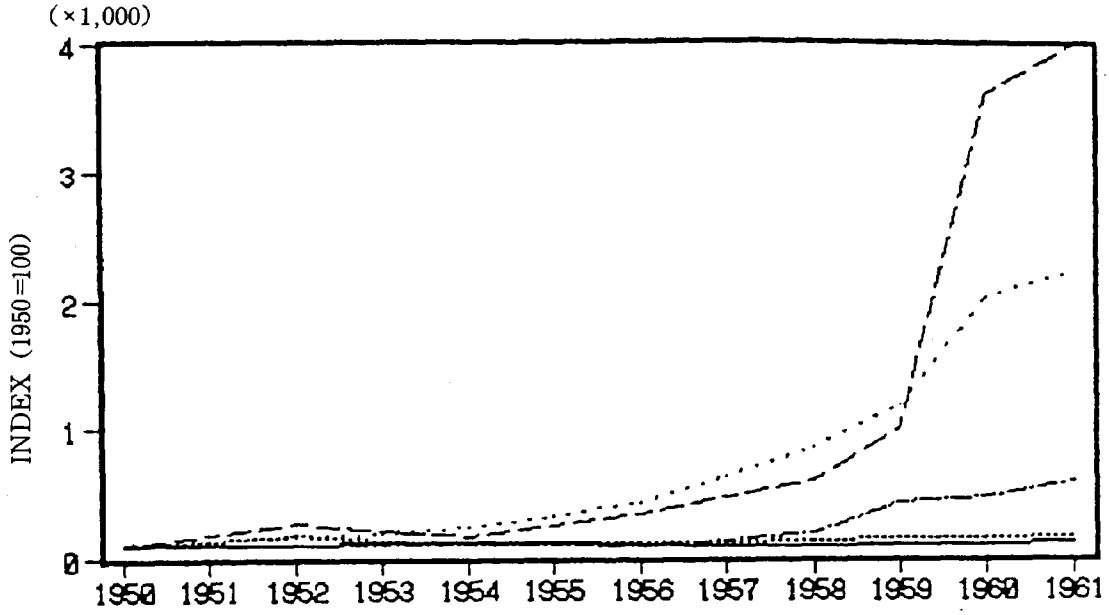

Fig. 2 Indices of Crop Production, 1950 - 1961

Source : Data from Department of Agricultural Economics, Thailand.

induced by the increases in production and export values of those cash crops in relation to rice. As shown in Fig. 2, the indices for the production of maize and kenaf gradually increased from the mid-1950s and sharply increased from 1959 to 1960. The index for cassava started a rapid increase in 1958. However, the indices for the production of the prewar traditional crops, rice and rubber, were almost constant during the period 1950-61. Fig. 3 depicts the ratios of export values of maize, cassava, and kenaf to export values of rice during the period 1950-70. The ratios showed increasing trends from the mid-1950 s because the export values of these three cash crops grew much faster than that of rice.[13)]

With respect to the cost of institutional innovation, foreign assistance in the form of experts and grants lowered the cost of some types of agricultural research (such as breeding programs) for various crops in Thailand. Foreign assistance thus facilitated the postwar development of agricultural research so that it was able to respond to the existing potential benefits induced by the favorable agricultural export markets. Table 3 shows that many research programs, such as breeding programs, initiated in the postwar years were as-

13) On crop diversification in the postwar years, see Silcock [1970].

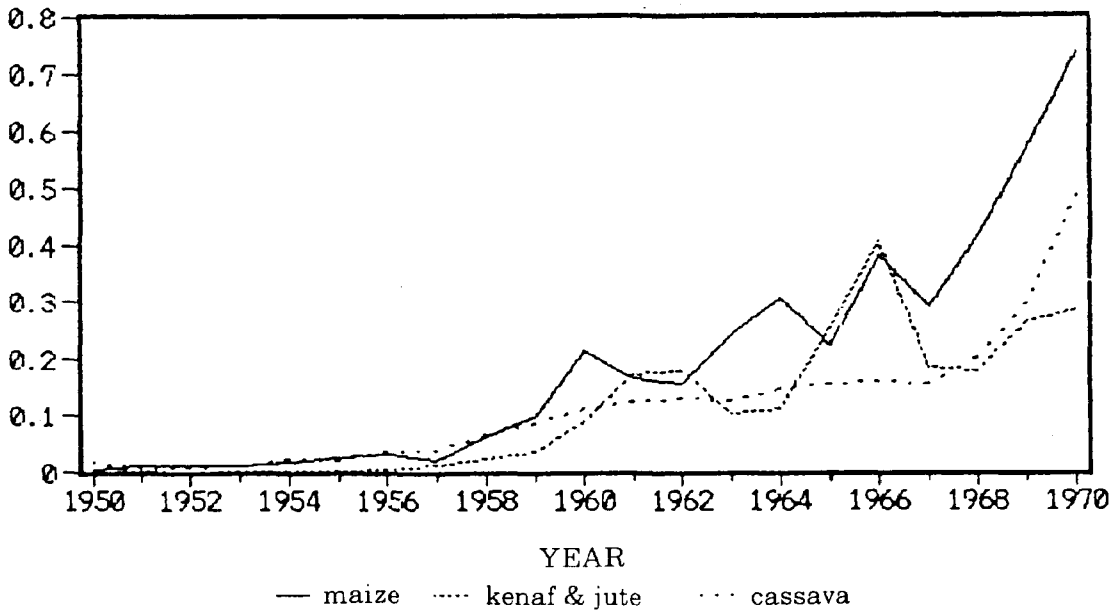

Fig. 3 Ratios of Export Value of Maize, Cassava, and Kenaf and Jute to Export Value of Rice

Source : Data from Department of Agricultural Economics, Thailand.

sisted by foreign agencies. In addition, in the 1960 s, USOM (the U. S. Operations Mission) supported an education program for Thai students to study agriculture in the United States [Rungruang 1986].

Judging from the fact that the limited research capacity, especially the supply of scientists, was an important bottleneck in the development of agricultural research in Thailand in the prewar period, the role of foreign assistance in the postwar period in the process of building up domestic research capacity is considered to be crucial.

II-2 *Reorganization of the Department of Agriculture in 1973*

Before 1973, there were two major departments under the Ministry of Agriculture conducting crop research: the Rice Department, which was responsible for rice research, and the Department of Agriculture, which was responsible for research into crops other than rice. In 1973, the Rice Department was downgraded into the Rice Division under the new Department of Agriculture. The budget of 53.4 million baht in 1972 for the Rice Department dropped to 34.6 million baht in 1973 for the Rice Division. Since then, there has been only one key department under the Ministry of Agriculture and Cooperatives, namely, the Department of Agriculture, that has been responsible for crop research.

Before the Rice Department was down-

graded in 1973, its budget share in total budget for crop research (the summation of budget for the Rice Department and the Department of Agriculture) had been declining as the budget of the Department of Agriculture had increased at a faster rate. As shown in Table 4, the budgetary share of the Rice Department declined from 50.31 percent in 1959 to 34.33 percent in 1972. On the other hand, the budget of the Department of Agriculture increased rapidly and its share rose from 49.69 percent to 65.67 percent during the same period.

The decline in budgetary share for the Rice Department coincided with the diversification of Thai agriculture in field crops, as indicated in Fig. 2 and 3. The coincidence suggests that the institutional adjustment in 1973 was induced by the declining relative importance of rice in terms of production and exports.

Table 4 Budget of Rice Department and Department of Agriculture: 1959 - 72 (1962 Price)

Unit: Thousand Baht

Fiscal Year	Rice Department	Department of Agriculture	Total
1959	29,413	29,052	58,465
	50.31%	49.69%	100%
1961	22,135	26,840	48,975
	45.20%	54.80%	100%
1963	35,783	42,909	78,692
	45.47%	54.53%	100%
1965	48,471	54,192	102,663
	47.21%	52.79%	100%
1967	72,623	89,219	161,842
	44.87%	55.13%	100%
1969	44,676	78,819	123,495
	36.18%	63.82%	100%
1971	43,604	88,267	131,871
	33.07%	66.93%	100%
1972	42,716	81,717	124,433
	34.33%	65.67%	100%

Note: Before 1969, the Rice Department was responsible for rice research and extension while the Department of Agriculture was responsible for research and extension of crops other than rice. In 1969, extension works of the two departments were separated to form a new department, the Department of Agricultural Extension. Therefore, the data before 1969 include administration, research, and extension. Those since 1969 include administration and research only.

Source: Data from *Agricultural Statistics of Thailand*. Division of Agricultural Economics, Ministry of Agriculture and Cooperatives, Thailand. (Various years)

Ⅲ Development of Crop Research Since 1982

Between 1973 and 1981, there was no significant change in the crop research institution except for the steady growth of crop research activity represented by the steady increase in its expenditures. During 1975－81, public expenditures on crop research increased (at 1976 constant price) at the rate of 3.5 percent per annum, higher than the average of 2.2 percent per annum for total agricultural research. This increase can be explained to a large extent by a substantial increase in the number of crop research scientists at the rate of 6.5 percent per annum

Table 5 Regional Allocation of Rice Research Expenditure and Rice Research Expenditure per Unit Rice Planted Area (1976 Price)

Year	North	Northeast	Central Plain	South
Rice research expenditures (thousand baht)				
1975 - 1981 (Annual average)	3,181	4,318	8,803	2,148
1982	3,116	6,096	9,613	2,445
Rate of change* (%)	−2.02	41.16	9.21	13.85
Rice research expenditures per unit rice planted area (baht/1000 rai)**				
1975 - 1981 (Annual average)	257.97	161.69	578.58	544.49
1982	228.89	227.22	622.46	575.52
Rate of change* (%)	−11.27	40.53	7.59	5.70

* Rate of change in research expenditure is the percentage change in the amount of research expenditure of the year 1982 from the annual average expenditure of the 1975 - 1981 period.

** 1 rai = 0.16 hectare

Sources: Data for research expenditure are unpublished data from the Rice Research Institute, Thailand. Planted area data are from the Office of Agricultural Statistics, Ministry of Agriculture and Cooperatives, Thailand.

during the period.[14]

There have been three important institutional changes in crop research in 1982. They are (1) a change in the main target area of crop research from irrigated to rainfed production, (2) decentralization of crop research to regional agencies, and (3) the establishment of the Farming Systems Research Institute.

Ⅲ-1 *Change in the Main Target Area of Crop Research from Irrigated to Rainfed Production since 1982*

Before 1982, crop research, in particular rice research, was concentrated on crop production in irrigated areas. Table 5 shows that during 1975-81 the Central Plain, the region with about 65 percent of the country's total irrigated area and which produces about 70 percent of the marketable surplus of rice (total production deducted by on-farm consumption), received the largest amount of annual average rice research expenditures both in absolute terms (8,803 thousand baht per annum) and in terms of expenditures per unit rice planted area (578.58 baht per 1,000 rai).

Nevertheless, since 1982, the Depart-

14) Computed from Rungruang [1986: Table 2.1, 2.6, 2.11].

ment of Agriculture has defined the backward impoverished areas outside the irrigated areas (here called "rainfed poverty areas") as the main target area for public crop research [Thailand, DOA 1984 a]. At the same time it became policy to promote private firms to undertake research and extension in progressive agricultural areas [*ibid.*]. As for rice research, expenditure in 1982 in the Northeast increased sharply by about 40 percent from the annual average expenditures of the 1975－81 period (Table 5). The Northeast is a region with only 5 percent of its farmland irrigated. Further, it has the most serious problem of poverty, with thirty-six percent of its population in 1981 being defined as poor (having a standard of living so low that basic minimum food requirements and other human needs are not met) [Medhi 1985: 180－181]. Two special research projects, the Upland Rice Research Project and the Rainfed Rice Research Project for Poverty Areas, were implemented during 1983-86. The budgetary shares of these projects in total rice research were as high as 17.4, 12.9, and 13.5 percent in 1984, 1985, and 1986, respectively [Thailand, DOA 1985].

The change in the main target area of crop research to rainfed poverty areas since 1982 corresponds to the government's macro-policy stated in the Fifth Five-Year National Economic and Social Development Plan (1982－86) [Thailand, DOA 1984 a: 17]. In the plan, emphasis was placed on policies to rectify the income disparity among Thai population by raising the income of poor rural people.

It was an unbalanced increase in returns to land and labor (represented by unbalanced increase in income) within the rural sector, which was partly due to unbalanced public investment before 1982, that induced the adjustment in the national plan for public investment, including crop research. The Gini coefficient for the rural sector has significantly increased from 0.361 in 1962/63 to 0.437 in 1981, representing the deterioration of income distribution within the sector [Medhi 1985: 188]. Concentration of public investment during 1960－80 into such areas as research and large-scale irrigation projects brought about an improvement of productivity and income in progressive agricultural areas relative to rainfed areas [World Bank 1984]. On the other hand, a study by the National Economic and Social Development Board (NESDB) in 1975 found that the poor rural population in the Northeast were farmers in rainfed areas who had to allocate more than 80 percent of their low-productivity land to rice for self-consumption and who did not have other off-farm jobs [Kosit *et al.* 1981]. This implies low returns to land and labor, thus, low income to those farmers. Problems of instability in rice production and shortage of rice for consumption existed in poverty areas [Thailand, DAE no date].

Given this situation, there were potential social benefits (in terms of improvement of farm income and welfare of poor farmers) from public investment in rainfed poverty areas. The government expected that rice research and extension in these areas would increase land productivity and secure rice for consumption by farm households. As evidence, the Rainfed Rice Research Project for Poverty Areas had as its target to increase rice production in these areas by 50 kilogram per rai (the average paddy yield for rainfed rice in the Northeast was 220 kilograms per rai in 1976) and to build up public reserves of paddy for seed and consumption in villages [*ibid.*]. Improvement of rice yield would make it possible for farmers to allocate parts of their rice-planted areas to other cash crops to increase their income [Kosit *et al.* 1981].

The redirection of rice research was also made possible by a remarkable increase in manufacturing exports from around 1975, which reduced the country's reliance on the export of rice and other agricultural products for foreign reserves. The share of export value of manufactured products increased sharply from 2.4 percent in 1961 to 32.3 percent in 1980. On the other hand, the export share of agricultural products decreased from 86.4 to 51.2 percent during the same period (the remainder comprises mining, re-export, and others which declined from 11.2 to 6.9 percent). The share of rice export in total exports decreased from 36 percent in 1961 to 15.6 percent in 1980.[15)]

Ⅲ-2 *Decentralization of the Crop Research System in 1982*

Following Evenson's definition, "decentralization of agricultural research" refers to dispersion of authority and function for agricultural research to a regional level [Evenson *et al.* 1979]. With decentralization of agricultural research, agricultural scientists can conduct more relevant research since they have a better perception of the need of farmers, with whom they work closely [Hayami *et al.* 1975].

In order that crop research could effectively solve the production problems that are location-specific, the Thai government considered that problem-oriented research programs should be implemented under a decentralized system of agricultural research [WGATGD 1982: 76-79]. In 1981, the eight-year National Agricultural Research Program (NARP) of the Department of Agriculture was started. Its objective was to develop the capacity and capability of local experimental stations under a decentralized research system. Grants and loans were provided at the request of the Thai government by the World Bank, the International Fund for Agricultural Development (IFAD), and the Australian government.

15) Data for computation are from the Customs Department and Bank of Thailand.

Table 6 Distribution and Rate of Change of Graduate Staff* of Selected Research Institutes in the Central and Regional Research Agencies : 1979 and 1984

Unit : Persons

Degree	1979	1984	Rate of Change (%)
Rice research institute			
Central agencies**	95	39	−58.9
Regional agencies	117	249	112.8
Total	212	288	35.8
Field crops research institute			
Central agencies	126	29	−77.0
Regional agencies	65	208	220.0
Total	191	237	24.1
Horticulture research institute			
Central agencies	52	27	−48.1
Regional agencies	34	132	288.2
Total	86	159	84.9
Rubber research institute			
Central agencies	11	26	136.4
Regional agencies	66	101	53.0
Total	77	127	64.9
Sericulture research institute			
Central agencies	18	2	−88.9
Regional agencies	14	49	250.0
Total	32	51	59.4

* Graduate staff include those with B. S., M. S., and Ph. D. degrees.
** Central agencies are those research agencies in Bangkok. Regional agencies include research centers and experimental stations in local areas.
Source : Data from Personnel Division, Department of Agriculture, Thailand.

Under NARP, the Department of Agriculture was reorganized in 1982. Commodity research divisions (rice, rubber, field crops, horticulture, and sericulture divisions) were changed into commodity research institutes (for example, Rice Research Institute). Selected local experimental stations were upgraded as research centers directly supervising satellite experimental stations in their areas of responsibility. The decline in number of researchers in central research agencies in Bangkok and the increase in the number in regional agencies of most commodity research institutes between 1979 and 1984, as shown in Table 6, represent the fact that a number of researchers were moved from central research agencies in Bangkok to local research centers. In my field survey of research institutions in Thailand, such as Suphan Buri Rice Experimental Station in Suphan Buri Province and San Patong Rice Experimental Station in Chiang Mai Province, in August 1988, I wit-

nessed an improvement in the authority of researchers at local research centers and experimental stations. Local researchers could initiate research projects in response to the needs of farmers in their areas by proposing research projects through the research centers to the central research organizations in Bangkok.

This institutional change in 1982 was induced by two factors: (1) an increase in knowledge accumulated from experience on how to organize and manage research institutions more efficiently, and (2) the influence of the World Bank as a source of the loan for institutional change on the design of the new organization.

According to Hayami and Ruttan, knowledge that brings about consensus reduces "the cost of conflict" in the process of institutional change [Hayami and Ruttan 1985: 215]. In Thailand, knowledge of research management derived from experience brought about a consensus of opinion among researchers and decision-makers on the weak points of the pre-1982 research system and on the need for decentralization. Crop research in Thailand before 1982 had been centralized as stated in many reports [Amphon 1975 ; Rungruang 1986 (surveying various reports such as FAO Report in 1970)]. Based on his twenty-year experience as a scientist with the Department of Agriculture, in 1975 Amphon Sena-narong (who is at present the deputy director of the Department of Agriculture) recorded that most of research projects were initiated by central research agencies in Bangkok, where there was a concentration of researchers with higher status and, thus, higher authority. Local researchers had a minimal role in project initiation. As a result, many research projects could not respond to local needs [Amphon 1975 : 34]. His statement was consistent with the views of researchers whom I have interviewed in the field.[16] Amphon, as well as others, suggested the need for decentralization of agricultural research to local areas.

Although the consensus on the need for decentralization had prevailed since 1970 but it was not met by the government until 1982. In interviews, some researchers at the Department of Agriculture expressed strongly the opinion that the institutional adjustment in 1982 was influenced by the World Bank, which was a source of loan and a source from which the new design of research organization was proposed. Also, other officers suggested that the dispersion of agricultural scientists and decentralization of crop research to local areas in 1982 was made possible because of an increase in total number of agricultural scientists while the cen-

16) Researchers at San Patong Rice Experiment Station explained that before 1982 they conducted research programs which had been planned by the central agency but under the new system they could initiate research projects and propose them to the local research center under which they were supervised.

tral research agencies in Bangkok were already dense with researchers. As shown in Table 6, during 1979-84, the increase in total numbers of scientists (those who have at least B.S degree) was ranged between 24 percent for Field Crops Research Institute to 85 percent for Horticulture Research Institute. However, in 1979 central research agencies of most crop research institutes were already relatively dense since about a half or more than a half of total scientists of each institute were placed there.

Ⅲ-3 *Establishment of a Farming Systems Research Institute in 1982*

To raise the level of farm income, reduce farmers' risks in production of one crop, and promote the intensive use of land, a Farming Systems Research Institute was established in Bangkok in 1982. The establishment of this new research institute was the result of a declining land-labor ratio since 1975. The increasing scarcity of land relative to labor was accompanied by more intensive use of land by farmers. This created the expected benefit from publicly generating a technology that would increase the efficient use of land in response to the needs of farmers. The land-labor ratio in Thai agriculture had increased continuously from 1960 (about 5 rai per person) until it reached the turning point in 1975 (7.14 rai per person). Farmers increased their land use intensity (planted area per unit agricultural land) from a national average of 0.79 in 1975 to 0.86 in 1981. Areas under double and triple cropping increased by 80 percent from an index of 7.4 in crop year 1980/81 to 13.34 in 1986/87 [Thailand, OAE 1989]. Paddy, vegetables and fieldcrops are generally used in such farming systems.

Before 1982, the Thai government responded to farmers' needs by conducting farming systems research mainly under rice experimental stations. However, it appears that, as demand for research knowledge on farming systems increased, the existing research system, which was characterized by its commodity-oriented organizational structure (that is, each of the existing experimental stations was conducting research into particular commodities), did not function well. Because of the difficulty of fitting farming systems research into the existing research system, farming systems research was given low priority [WGATGD 1982: 78]. Its expenditures in 1981 accounted for only one-seventh of the expenditures on commodity crop research [Rungruang 1986: 37, Table 2.6]. The establishment of the Farming Systems Research Institute was an institutional innovation to overcome the limitation of the existing research system.

Ⅳ Summary and Conclusion

The development of agricultural research in Thailand can be summarized

as follows.

In the first period of development of crop research (1902-World War II), the doubling of textile imports in 1897-1902 led to the start of the first sericulture experimental station in 1902 and a cotton experimental station in 1915. The expected benefit from research was the saving of foreign exchange by the substitution of improved domestic textiles for the imports. Sericultural research was started before cotton because the Japanese government offered technical assistance by sending Japanese sericultural experts to be hired by Thai government.

The rapid expansion of rice exports from 1855 led to government policies before 1910 to promote the expansion of paddy land rather than rice research, since Thailand was then land-abundant. However, the low quality and low price of Thai rice in the world market around 1910 increased the expected benefit from exporting better quality rice. This induced the establishment of the first rice experimental station in 1916.

In general, the development of crop research in the pre-1930 period was slow because the government had relatively little interest in developing the agricultural sector, agricultural scientists were scarce, the government preferred to invest in projects that yielded definite, short-term returns, the world price of cotton yarn fell in the 1920s, and the government ran a budgetary deficit during 1920-25.

During the period of world recession (1929-30), Thailand's rice exports dropped considerably since it could not compete with the cheaper exports from Vietnam and Burma. This destabilized the country's economy, which depended greatly on the rice sector. The expected benefit from research to reduce the production cost of rice and to promote agricultural diversification into products other than rice induced the revival of public research from 1930.

In the second period of development for crop research (post-World War II-1981), the progress in research was attributable to the favorable agricultural export markets in the postwar years and to foreign assistance. A Rice Breeding Program was started in 1950, followed by research on rubber technology and breeding programs of maize, cotton, kenaf and jute. As the share of rice production and exports declined from 1955 due to the faster increase in production and exports of other field crops, the budget share of rice research in total crop research declined. This led to the downgrading of the Rice Department to the Rice Division under the Department of Agriculture in 1973.

In the third period of development of crop research since 1982, the main target area of crop research was redirected from irrigated production to rainfed production. The unbalanced growth of income in the rural sector during 1960-80 induced the adjustment of the national plan. The Fifth National Economic and Social Development Plan

(1982－86), which emphasized rectifying the problem of worsened income distribution, changed the direction of crop research with the objective of stabilizing and increasing the agricultural production of poor farmers. In addition, the considerable increase in manufacturing exports from around 1975 reduced the country's reliance on rice exports and enabled the redirection of rice and crop research toward rainfed areas.

The Department of Agriculture was reorganized in 1982 in order to develop the capacity of local experimental stations under a decentralized system of crop research. A number of agricultural scientists were moved from central research agencies in Bangkok to local research agencies, and local researchers were provided with authority to initiate research projects in response to the needs of farmers in their areas of responsibility. Accumulated knowledge on research management derived from experience brought about a consensus of opinion among researchers and decision-makers in favor of an institutional adjustment toward a more efficient decentralized research system. By proposing the design of a new organization and being a source of loan, the World Bank also influenced on the supply of institutional change.

The establishment of the Farming Systems Research Institute was another institutional innovation in 1982. It was induced by the declining land-labor ratio which started around 1974.

In conclusion, the theory of induced institutional innovation can explain, to a large extent, the development of crop research in Thailand. The study shows that, during the past eighty-five years, the Thai government has innovated and adjusted crop research institution rationally (but not necessarily efficiently) in response to changes in expected benefit from and cost of innovating the research institution, which were determined by changes in product markets, factor endowments, technical assistance from abroad, and the increase in stock of knowledge on research management and organization.

Among these inducing factors, changes in export markets for crops and institutional and technological transfer as foreign assistance were the most important.

Since crops have been major exports of Thailand, the Thai government has actively responded to changes in world prices of those products. Changes in export markets for crops induced such innovations as a rice experimental station (1916) and the revival of crop research (1930 s), and they stimulated more active research activity into various crops (1950 s－1960 s).

Technical assistance from abroad played a very important role in building up research capacity in Thailand, particularly in the first and second periods of research development, when agricultural scientists were scarce. In the third period, foreign assistance has influenced the design of the new or-

ganization of the Department of Agriculture.

We can also conclude that the emphasis of crop research has changed over time, following the overall economic change of the country. Before 1982, when Thailand depended heavily on crop exports, the research institution developed mainly in response to the changes in the agricultural export market in order to accumulate foreign exchange. After 1982, when income distribution had continued to worsen and agricultural land had become scarce, crop research in Thailand developed in order to be able to respond better to the needs of farmers in rainfed poverty areas and to the scarcity of land.

Two major limitations exists in this study and may be topics for further studies. First, the study has proposed many hypotheses that need more rigorous proofs. Second, by attempting to explain the cause of the 'actual' change of the research institution, the study ignores cases in which there may have been demand for institutional change, but which was not met by the government.

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